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Environmental Technology Verification (ETV)

Coatings and Coating Equipment Program (CCEP)

Focus Area Investigation Report

October 13, 1997

Concurrent Technologies Corporation
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EXECUTIVE SUMMARY

The U.S. Environmental Protection Agency (EPA) tasked Concurrent Technologies Corporation (*CTC*) to operate the Environmental Technology Verification (ETV) Coatings and Coating Equipment Program (CCEP).

This report documents the research effort to identify initial focus areas for verification testing under this ETV pilot program for FY97. Initial focus areas were chosen based on the following input: priorities identified at the first stakeholder meeting on March 21, 1997; information obtained from industry trade associations, organizations, and publications on coatings and equipment usage projections; and the experiences of *CTC* and the EPA on similar projects.

The second stakeholder meeting is scheduled for October 30, 1997. The decisions and priorities for focus areas may be revised based on future stakeholder meetings and other events or knowledge obtained by the program.

This report is being provided to the program stakeholders for comment and concurrence on the decisions for initial focus areas that are presented. The program will proceed based on these decisions unless the majority of the stakeholders object.

1.0 INTRODUCTION

Concurrent Technologies Corporation (*CTC*) has been tasked to establish the Environmental Technology Verification (ETV) Coatings and Coating Equipment Program (CCEP). *CTC* and the Air Pollution Prevention and Control Division (APPCD) of the Environmental Protection Agency (EPA) will work closely with industry to select the key test protocol criteria for verifying innovative coating technologies.

Surface coating was a focus area of the FY 1995 Environmental Technology Initiative (ETI) and accounts for 20% of stationary area source volatile organic compound (VOC) emissions. Surface coating is also a significant source of air toxic or hazardous air pollutant (HAP) emissions. Most VOC and HAP emissions from surface coating operations are the result of evaporation immediately after the coating has been applied and while it is being cured. Some emissions may also occur while the coatings are prepared for application. Coatings are formulated from over 50 compounds, including toluene, xylene, methyl ethyl ketone, and methyl chloroform. Most of these compounds are solvents that are both VOCs and HAPs. HAPs contribute to cancer, other non-cancerous health risks, and ecological damage.

The ETV-CCEP supports the environmental goals of the Clean Air Act Amendments of 1990 by identifying emission reduction techniques for the organic coatings industry. The ETV-CCEP will provide information to the coatings industry about those coating technologies that claim to have environmental benefits over existing products or technologies.

Many manufacturers of coatings and coating application equipment claim to market products that would significantly reduce VOC and HAP emissions in comparison with existing products and equipment. Increased use of these alternative coatings and processes would prevent pollution from these sources. Most of the manufacturers' claims are not verified by an unbiased third party. Market penetration can be poor due to concerns about quality, effects on production rates, compatibility with current equipment and processes, and cost of implementation.

The ETV-CCEP will assist technology developers to generate credible performance data about their technologies. This assistance will involve developing, piloting, and proving a standardized test protocol. It will generate performance data for several innovative products and will establish a pilot ETV facility operated by *CTC*. The desired innovations will allow the cost-effective and more environmentally friendly coating of a wide range of substrates.

1.1 Objectives of the ETV-CCEP

There are three primary objectives of the ETV-CCEP:

- Develop standardized test protocols to verify the acceptability of lower polluting innovative coatings and coating application techniques for metal, plastic, wood, and other substrates in a broad range of industries
- Provide credible third-party environmental, performance, and cost data about potentially lower polluting innovative coatings and coating application technologies to end users
- Establish self-supporting technology-verification capabilities at *CTC*.

1.2 Focus Area Investigation Prior to First Stakeholders Meeting

Initially, *CTC* developed a general list of possible technology focus areas. This list (below) was then used to identify more specific focus areas based on related projects and stakeholder feedback prior to the first meeting.

Coating Application Technologies
Liquid spray coating
Conventional air atomization spray
Airless spray
Air electrostatic spray
Air-assisted airless electrostatic spray
High-volume low-pressure (HVLP) spray
Air-assisted airless spray
Rotating discs and bells
Liquid dip coating
    Electrocoating
    Autodeposition
    Dip
    Centrifugal coaters
Liquid flow coating
Liquid curtain coating
Liquid roller coating
Powder coating
    Fluidized beds
    Electrostatic fluidized beds
    Electrostatic spray
Radiation-curable coating systems

Coatings
Conventional coatings containing VOCs
Water-borne coatings
- Water emulsion coatings
- Water-soluble coatings
- Water-reducible coatings
- Resins

Electrocoatings
- Anodic epoxy
- Anodic acrylic
- Cathodic epoxy
- Cathodic acrylic

High-solids coatings
- Ketone and glycol ether solvents
- Polyesters
- Alkyds
- Epoxies
- Urethanes
- Silicones
- Acrylics
- Lower molecular weight oligomers

Thermoplastic powder coatings (approx. 10% of powder technology)
- PVC
- Polyamides (Nylon 11 and 12)
- Polyethylene (LDPE and HDPE)
- Polypropylene
- Ethylenevinylacetate (EVA)

Thermosetting powder coatings (approx. 90% of powder technology)
- Epoxy
- Polyester-urethane
- Polyester-TGIC
- Polyester-amide
- Acrylic (Urethane and GMA)

Finishing Systems
Primers
One-coat enamels
Intermediate coats
Top coats
Performance additives

Resin Types
Acrylics
Alkyds
Epoxies
Polyesters
Polyurethanes
Vinyls
Amines
Cellulose esters
Fluorocarbons
Oleoresinous
Phenolics
Polyamides
Polyimides
Polyolefins
Silicones
Synthetic rubbers
Modified resins

In anticipation of the first stakeholders meeting and based on *CTC*'s experience in the field, *CTC* narrowed the list of potential focus areas to be discussed:

Coating Application Technologies
HVLP equipment performance
Liquid spray-painting equipment performance
Compressed air HVLP vs. turbine-powered HVLP spray units
Electrostatic spray unit with voltage-lock technology for water-borne paints
Paint heaters
Plural-component spray units
Powder-coating electrostatic disk
High-speed rotary electrostatic atomizers
Paint overspray collection and recycling systems
Supercritical CO_2

Coatings
Water-borne industrial paints
Clear E-coat lacquer for bright metal
UV-curable coatings for aluminum wheels
Low-temperature curing coatings
UV primers for sheet-molded compounds
Two-component paints
Paint additives
Autophoretic coatings vs. electrophoretic coatings

1.3 First Stakeholders Meeting Discussion

At the first stakeholders meeting on March 21, 1997, a consensus was reached to start focus area discussions by considering the list of industries for which MACT regulatory review is about to start (listed below). From this list, the industries that have the greatest potential for small business impact were chosen, namely metal furniture, miscellaneous metal parts, and plastic parts and products. *CTC* was tasked with determining what technology verification would have a significant impact in each of these industries. From that information, initial focus areas would be chosen.

Industries Slated for MACT Regulatory Review (with VOC emissions in tons/year)

Metal cans	(102k)
Metal coils	(53k)
Misc. metal parts*	(16k)
Large appliances	(18k)
Metal furniture*	(48k)
Automotive and light-duty truck OEM	(82k)
Plastic parts and products*	(11k)
Paper and film	(121k)
Flatwood paneling	(5k)
Fabric printing, coating, and dyeing	(36k)

* significant small business impact

Discussions led to the identification of these priority focus areas:

- Substrates: metal furniture, misc. metal parts, automotive suppliers
- Coatings: water-borne industrial paints, powder coatings, UV-curable coatings (control: conventional coatings)
- Applications: HVLP equipment performance, rotary disk/bell, electrostatic spray

Further discussion among the stakeholders led to the conclusion that equipment or process verification would have a greater impact than coatings verification. Because manufacturing technologies and processes used in the metal furniture industry could be more easily identified, this industry was chosen for selecting the initial focus area technology.

2.0 APPROACH

CTC personnel used an array of tactics to ensure a thorough investigation of potential focus areas. A detailed survey of end users was not conducted due to the amount of time required to conduct the survey and the time needed for the EPA Office of Management and Budget (OMB) to approve surveys under the Paperwork Reduction Act. Telephone conversations and literature reviews accounted for the heart of the investigation. The contacts and information resources are listed below.

CTC (internal reports and original focus area list)

EPA (National Air Pollutant Emission Trends 1900–1995 Report)

Industry Trade Associations:

- Association of Finishing Processors/Society of Manufacturing Engineers (AFP/SME)
- American Electroplaters and Surface Finishers Society (AESF)
- Business and Institutional Furniture Manufacturers Association (BIFMA) International
- American Housewares Manufacturers Association (AHMA)
- Chemical Coaters Association, Inc. (CCAI)
- Federation of Societies for Coating Technology (FSCT)
- Institute of Advanced Manufacturing Sciences (IAMS)
- International Cooperative for Environmental Leadership (ICEL)
- Mass Finishing Job Shops Association (MFJSA)
- Metal Finishing Suppliers Association (MFSA)
- National Association of Metal Finishers (NAMF)
- National Paint and Coatings Association (NPCA)
- National Spray Equipment Manufacturers Association (NSEMA)
- Powder Coatings Institute (PCI)
- Rad Tech International

Department of Defense (DOD) facility surveys

Companies:

- Herman Miller Furniture
- Nordson

Consultants:

- (A major industry consulting and resource group)
- Carl P. Izzo

Literature/Internet Searches:

- *CTC* library and online searches
- Enviro$ense website
- Industrial Paint & Powder magazine
- Standard Industrial Classification (SIC) Codes

3.0 RESULTS OF FOCUS AREA INVESTIGATION

3.1 Environmental Protection Agency (EPA)

The National Air Pollutant Emission Trends 1990–1995 Report, by Mohammed Serageldin and Bill Johnson for the Office of Compliance Sector Notebook Project, supplied the numbers for the VOC emissions listed on page 5 under the Industries Slated for MACT Regulatory Review.

Mohammed Serageldin of the EPA is heading the MACT review of the metal furniture industry and Bill Johnson is assisting. Both noted that no survey of the metal furniture industry was going to be undertaken for the current review. The last information formally gathered on the industry was reported in 1977 and 1978 (documents EPA-450/2-77-032 and EPA-450/2-78-015, respectively) and co-authored by Mr. Johnson. These documents were received and reviewed, but were too outdated to be used in for establishing current technology usage and needs.

The Office of Compliance Sector Notebook Project profiled the fabricated metal products industry, including the metal furniture industry, in document EPA-310-R-95-007. This document details all the types of coatings and equipment used in the metal furniture industry prior to 1995. The document does not breakdown or indicate the percentage of the industry that used a particular type of coating or equipment. The document does call attention to the standard method used for determining environmental performance for surface coating of metal furniture (40 CFR Part 60, Subpart EE). It states that (using the prescribed averaging method over a month) no manufacturer will exceed 0.90 kilograms of VOC per liter of coating solids as applied.

3.2 Industry Trade Associations

Association of Finishing Processors/Society of Manufacturing Engineers (AFP/SME) - (313) 271-1500

Debbie Clark said that AFP/SME could contact people knowledgeable about the metal furniture industry to discuss the types of coatings and equipment used in the industry. C. P. Izzo is a member and, through his affiliation, was given a contact at a major industry consulting and resource group (see the following).

American Electroplaters and Surface Finishers Society (AESF) - (407) 281-6441

The initial person contacted at AESF suggested talking to Dick Baker of AESF about coatings and equipment used in the metal furniture industry. AESF is primarily focused on inorganic coatings and processes. To date, no relevant information has been obtained.

Business and Institutional Furniture Manufacturers Association (BIFMA) International - (616) 285-3963, (616) 285-3765 (fax)

BIFMA is the main association for the furniture industry. Brad Miller, director of Government Affairs, was very interested in the ETV-CCEP's work. He was, however, slightly overwhelmed by the metal furniture industry being reviewed by the MACT Regulators, working with the Indoor Air Quality pilot ETV program, and now being asked to provide information to the ETV-CCEP. After being assured that the ETV-CCEP was only interested in BIFMA as it supported the end users, he was willing to help as best he could.

BIFMA is currently surveying the metal furniture industry for the first time to the best of Mr. Miller's knowledge. This survey is to determine what technologies are being used and what needs the industry sees for itself in the future. The survey forms were to be completed and forwarded to BIFMA by April 25, 1997, and distributed to the participants (and presumably BIFMA members) in May or June. On April 30, 1997, Mr. Miller said that the review committee was meeting that day to discuss the quantity of responses and that he would mention the ETV-CCEP's request for a copy of the results at this meeting. No further information has been received at this time.

On July 9, 1997, Mr. Miller contacted *CTC* to discuss the survey on the metal furniture industry. Because of a very low response, BIFMA decided to abandon the survey and concentrate its efforts with the PMACT. Unless the PMACT requires that the survey be continued, BIFMA will not make any further requests to the furniture manufacturing industry.

Mr. Miller also noted that BIFMA has a website at *http://www.bifma.com* and suggested looking there for more information about the industry and the standards used in testing within the industry. The ANSI/BIFMA standards that were listed were only for mechanical performance of the furniture. In addition, the website listed test labs, BIFMA members (companies) on the Internet, and sales and shipping information pertaining to the industry. Unfortunately, the sales and shipping data only gave total sales in dollars and pounds shipped (import/export) for the industry as a whole and not by product type.

American Housewares Manufacturers Association (AHMA) - (847) 292-4200

(Contact suggested by NAMF representative.) AHMA does not have any information available about the types of coatings or equipment used in the metal furniture industry.

Chemical Coaters Association, Inc. (CCAI) - (513) 624-6767

Brian Schweitzer of *CTC* presented an overview of the ETV-CCEP to the corporate members at the CCAI Annual Meeting in June 1997. Positive feedback was obtained from the user community on the status and plans for focus area testing.

Larry Melgary, president of CCAI, was contacted as part of the fact-finding process and is willing to help develop a contact list of metal furniture and miscellaneous metal parts coaters for future discussions.

Federation of Societies for Coating Technology (FSCT) - (610) 940-0777

Bob Ziegler, executive director, said that FSCT did not have information on coatings and equipment in the metal furniture industry.

Institute of Advanced Manufacturing Sciences (IAMS) - (513) 948-2000, website at *http://www.iams.org/p2irisde/metalfin.htm/*

On its website, IAMS provides a report that it completed with funding from the Ohio Environmental Education Fund. Unfortunately, this report, titled, "A Pollution Prevention Resource Manual for Metal Finishers," centers on efforts to reduce wastewater only and did not address coatings or coating equipment.

International Cooperative for Environmental Leadership (ICEL) - website at *http://www.icel.org*

At the March 21, 1997, stakeholders meeting, Vic Young noted that the ICEL had a matrix that described the relative impact of and relative potential for pollution prevention for various coating technologies (Appendix A). An important item to note is the relative potential for pollution prevention for high-solids coatings compared to conventional low-solids coating technology.

Mass Finishing Job Shops Association (MFJSA) - Mike Crotty, executive director, (800) 383-1101

Mike Crotty, executive director of MFJSA and president of KVF Quad, stated that MFJSA does not have any information about the types of coatings and equipment used in the metal furniture industry. Mr. Crotty's personal knowledge of this

industry and the miscellaneous parts industry, however, indicates that the coaters are quickly leaving conventional spray coating because of regulatory considerations. (Information about the ETV-CCEP was sent to Mr. Crotty at his request.)

Metal Finishing Suppliers Association (MFSA) - (630) 887 0797

C. P. Izzo contacted Richard Crane of the MFSA who suggested contacting the National Paint and Coatings Association.

National Association of Metal Finishers (NAMF) - (703) 709-8299

The association said it would try to find someone within NAMF to contact about the metal furniture industry, but it has not responded at the time this report was written. The association suggested contacting AHMA.

National Paint and Coatings Association (NPCA) - (202) 462-6272

Bob Nelson, executive director, stated that in 1995 the NPCA published a survey of coating types in the metal furniture industry OEM in 1994. NPCA started another survey in 1996 that should be published some time this year, but Bob Nelson did not know when. He mentioned that Ellen Ducey of the Coatings and Consumer Products group at the EPA in Research Triangle Park, N.C., has a copy of the report from 1995. Bob Nelson verbally conveyed the results given in that report over the phone (see Table 1 at the end of this section).

In addition to the breakdown of coating types used in the industry, the report summarizes products coated (listed below) and volume of coatings used by the industry in 1994. The report, however, did not provide a breakdown of coating types by product coated.

Product Breakdown as Percentage of Coatings Used by Metal Furniture Industry in 1994

Metal office furniture	25%
Partitions and fixtures	25%
Household furniture	10%
Public building furniture	5%
Other office and household items	35%
(no definitions of the categories were given)	

21.2 million gallons of coatings were used in 1994, not including powder and coil.

Coatings Breakdown as Percentage of Total Used by Metal Furniture Industry in 1994

High-solids liquid	32%
Powder	25%
Conventional (low-solids)	22%
Coil	4%
Other	17%

Liquid coatings were supplied by a large number of companies; however, the ten largest of the companies supplied 75% of the coatings.

Product Breakdown as a Percentage of All Powder Coatings Used in 1994

General metal finishing	43%
Appliances	18%
Automotive OEM	15%
Metal furniture	10%
Machining and equipment	9%
Electrical	5%

In 1994, powder coatings contributed:

19.9% of OEM coatings by volume

11.4% of OEM coatings by value ($624 million)

In 1994, a total of 228 million pounds of powder coatings were used at 12–25% annual growth.

There are at least 60 powder coating manufacturers in the U.S., with the five largest controlling approximately 70% of the market.

Powder Coatings Breakdown (by type) as a Percentage of Total Used in 1994

Polyester, blocked Isocyanate	30%
Epoxy	27%
Polyester, TGIC-cured	23%
Epoxy/Polyester	17%
Acrylic	3%

Other Industrial Product Finishes (Example Products)

Musical instruments	Signs and advertising displays
Toys	Pipe
Sporting equipment	Rebar
Housewares	Other miscellaneous metal and plastic parts

In 1994, a total of 23 million gallons were used, excluding powder, at a value of $333 million.

Other Industrial Product Finish Coatings by Technology (1994)

Powder	42%
Conventional (low-solids)	15%
High solids	10%
Water-borne	10%
Electrodeposition	7%
Other	16%

In 1994, a total of 26 million gallons of coil, sheet, and strip coatings were used at a value of $460 million.

Coil Coatings Breakdown (by type) as a Percentage of Total Used in 1994

Polyester-based	40%
Epoxy	30%
Plastisol, Organisol	18%
Water-based	6%
Fluoropolymer-based	3%
Other	3%

In 1994, a total of 7.6 million gallons of paint were used in the appliance coating industry at a value of $130 million.

Appliance Coatings Breakdown (by type) as a Percentage of Total Used in 1994

Powder	57%
High-solids	13%
Coil	11%
Electrodeposition	10%
Conventional (low-solids)	5%
Coatings for plastics	4%

When asked about specific performance standards within the metal furniture industry, Mr. Nelson commented that NPCA has a policy of not addressing specific standards.

National Spray Equipment Manufacturers Association (NSEMA)

C. P. Izzo contacted Don Scarborough of the NSEMA. At the time this report was written, Mr. Scarborough did not have the marketing information immediately available, but said he will canvas the members at the next NSEMA meeting.

Powder Coatings Institute (PCI) - (703) 684-1770

C. P. Izzo contacted Gregg Bocchi of PCI. Mr. Bocchi told Mr. Izzo the results of a 1995 PCI survey on coating types for all metal parts industries. These results, in conjunction with information from the 1996 and 1997 Industrial Paint and Powder surveys, were combined for comparison as shown in Table 1 below.

CTC made further verbal contacts to determine the market size for powder coating users. This number was estimated at 4,000 powder coating users in the U.S. market according to the PCI.

C. P. Izzo extracted a table from "Powder Coating, The Complete Finisher's Handbook," published by the PCI. The table shows commercial end users for the various types of electrostatic sprayable thermosetting powder coatings, divided by resin type.

Table 1. Thermosetting Powder Coatings Usage by Resin Type

	Polyester Urethane	TGIC Urethane	GMA Acrylic	Acrylic Urethane	Acrylic Hybrid	Epoxy	Epoxy Hybrid
Air Conditioners	X	X					
Alum. Extrusions		X		X	X		
Appliances	X	X	X			X	X
Automotive	X	X	X	X		X	X
Electrical Equipment	X	X				X	
Metal Furniture	X	X				X	X
Lawn and Garden Equipment	X					X	
Lighting Fixtures	X				X		
Pipe Coatings						X	
Playground Equipment	X	X					
Plumbing Fixtures			X	X			
Rebars						X	
Shelving						X	X

Rad Tech International - (703) 534-9313

C. P. Izzo contacted Alexander Ross of Rad Tech International, who suggested contacting Mohammed Serageldin at the EPA for his "Metal Furniture Survey."

3.3 Department of Defense (DOD)

In addition to work directly related to the ETV-CCEP, surveys performed in 1996 by *CTC* under the "Paint Handling and Spraying Equipment Testing, Evaluation, and Training" project for the DOD were reviewed. This project's purpose was to adapt advanced commercial paint handling and spraying equipment for use in military industrial facilities. Within these reports, surveys were taken of over 20 DOD industrial facilities. The surveys detailed the types of coatings and coating equipment used at each site, as well as the apparent performance of each type, and the types of equipment each facility wanted studied for future implementation. The results showed that there was a definite movement away from conventional spray technology to HVLP technology (HVLP at several of the sites was used for up to 60% of the coatings work by volume). A frequent problem was noted with the HVLP systems. The operators did not have as much control over the spray pattern when doing detailed application compared to using conventional spray systems.

As part of the surveys, equipment or technologies were prioritized according to site interest or need for implementation. Below is a summary of site responses indicating technology or equipment in one or more of the following three categories (with number of sites):

- Planned to be tested by the site
- Planned to be implemented by the site
- Site would like evaluation/demonstration by *CTC*.

1. HVLP systems (11)
2. Electrostatic systems (8)
3. Air assisted airless systems (5)
4. Smith-Eastern Air Verter system (3)
5. Airless systems (3)
6. Plural component systems (2)
7. Paint heaters (2)
8. Graco Hydra-Cat system (2)
9. Graco Optimiser (1)
10. Robotic systems (1)
11. Unicarb™ system (1)
12. Can-Am Turbine system (1)
13. Graco Bulldog system (1)
14. Supply systems (1)

Responding DOD Sites

Air Logistics Centers	Naval Shipyards	Army Depots
Ogden ALC	Norfolk NSY	Anniston AD
Oklahoma City ALC	Portsmouth NSY	Corpus Christi AD
San Antonio ALC	Puget Sound NSY	Letterkenny AD
Warner-Robins ALC		Red River AD
		Tobyhanna AD

Naval Aviation Depots	Marine Corps Logistics Bases
Cherry Point NADEP	Albany MCLB
Jacksonville NADEP	Barstow MCLB
Norfolk NADEP	
North Island NADEP	Air Force Bases
Pensacola NADEP	Newark AFB

Number of Facilities Using Coatings:

High solids	14
Plural component	14
Solvent-borne	13
Water-borne	11

3.4 Companies

Herman Miller Furniture

Bob McCrillis of the EPA was going to talk with contacts at the Herman Miller Furniture Company with whom he had worked previously on another coatings-related project. At the time this report was written, Mr. McCrillis had not heard from his contacts.

Nordson - (216) 985-4309

C. P. Izzo contacted John Kost, regional powder sales manager for Nordson, concerning information pertaining to the types of coatings and equipment used in the metal furniture industry. At the time this report was written, Mr. Kost was still gathering the data from his sources, and, therefore, had not conveyed any further information to Mr. Izzo.

3.5 Consultants

(A major industry consulting and resource group)

C. P. Izzo contacted a major industry consulting and information resource group. This company continually surveys the coatings and coatings equipment market and provides information pertaining to coatings and coating equipment usage. Presently, the company can provide details of coating usage by coating types and resin types, as well as usage by 16 different application methods. The reports pertaining to the metal furniture and miscellaneous metal parts industries were ordered and reviewed, and found consistent with other focus area investigation findings.

Carl P. Izzo - (412) 733-5103

As detailed throughout this section, Mr. Izzo has been instrumental in assisting in making contacts within the coatings industry as well as helping to define the *CTC* original focus area list. Mr. Izzo also provided a copy of a 1994 report he prepared for *CTC*. This report was a market study to identify possible clients and the market size for *CTC* in the coatings industry as a whole. This background information reported the number of users of various types of coating technologies throughout the whole coating industry.

3.6 Literature/Internet Searches

CTC Literature and Online Searches

CTC performed an exhaustive library search limited to articles within the past ten years under the subject headings of equipment, finish, paint, coat, metal, and furniture. Approximately 20 articles were found, 6 of which were published within the past five years. None of the articles had specific information about coatings usage or coating equipment in the metal furniture industry, but nearly half were written about powder coatings, showing that the powder coatings industry has been interested in making inroads into the market over the past ten years.

Because of the frequent occurrence of these powder coating articles, a further search was performed to acquire a list of powder coating manufacturers to date for future solicitation. Approximately 50 powder coating manufacturers were listed in either the 1996 Products Finishing Directory and Technology Guide, Industrial Paint & Powder journal, Powder Coating journal, or the 1996 Thomas Register.

Likewise, a search was performed to obtain a list of companies that produce HVLP equipment. This was chosen as the primary focus area as a result of the DOD survey that revealed that the HVLP systems were given the highest priority

for further testing and/or implementation. Approximately 30 companies were identified as HVLP manufacturers according to the same references listed above.

Enviro$ense Website - *http://es.inel.gov*

A review of non-traditional coatings by Hank Birdsong of the DOD is available on this website. In addition, a document titled "A Pollution Prevention Guide for Metal Fabricators" is available, but it only provides general methods for reducing waste such as recycling and reducing the spray amount for coatings.

Industrial Paint & Powder Magazine

C. P. Izzo found data pertaining to coatings usage for the metal parts industries reported in the January 1996 issue of Industrial Paint & Powder magazine. This information was combined with 1997 data from a market study and information from the PCI to form a more accurate summary and projection for coatings usage as part of the total market (see Table 2 below).

Industrial Paint & Powder magazine, via the Department of Commerce, supplied *CTC* with U.S. market information on the quantity and value for product coatings purchased in 1994 and 1995. They also reported a projection for the product coatings market share for 1996 (see Table 2 below).

Table 2. Total U.S. Market for Product Coatings by Type of Product Finish

Type of Product Finish	**1994 Quantity** (in 1,000 gal.)	**1994 Value** (in $1,000)	**1995 Quantity** (in 1,000 gal.)	**1995 Value** (in $1,000)
Automobiles and light trucks	45	1,126	45	1,092
Automotive parts	2	67	2	69
Heavy-duty truck, bus, RV	15	365	14	336
Other transportation	10	148	5	96
Appliance, heating, and AC	6	93	7	107
Wood furniture, cabinets, fixtures	37	355	36	345
Wood and composition board	10	107	11	119
Metal building finishes	29	477	29	514
Container and closures	55	488	51	487
Machinery and equipment	18	264	17	253
Non-wood furniture and fixtures	20	309	18	276
Paper, paper board, film, foil	16	128	16	129
Electrical insulating coatings	5	126	5	103
Appliance powder coatings	11	82	16	90
Automotive powder coatings	12	109	13	98
Architectural powder coatings	4	29	3	23

Table 2. Total U.S. Market for Product Coatings by Type of Product Finish (continued)

Type of Product Finish	1994 Quantity (in 1,000 gal.)	1994 Value (in $1,000)	1995 Quantity (in 1,000 gal.)	1995 Value (in $1,000)
Lawn and garden powder coatings	3	27	4	33
General metal powder coatings	31	246	26	204
Other industrial product finishes	59	466	57	751
Totals	**390**	**5,339**	**377**	**5,126**

The projected sales for product coatings in 1996 were estimated at 399 millions of gallons, a similar increase compared to the change between 1994 and 1995. On the other hand, the 1996 projection for the value of the product coatings was $6.1 million, an increase of $0.8 million or 14% from 1995. This 14% increase was more significant when compared to the slight 5% change from the previous year.

Industrial Paint & Powder magazine provided *CTC* with the results from a 1997 finisher market study. The magazine conducted this survey to help the supplier community better understand current conditions and future opportunities in the industrial finishing market. (See Tables 3–11 and Figures 1 and 2 below.)

Table 3. Industrial Paint & Powder Magazine Survey Response

	1996	1995	1994
Number of questionnaires mailed	8000	8000	4000
Non-deliverable questionnaires	84	122	56
Number of questionnaires returned	1584	1762	714
Response rate	20.0%	22.4%	18.1%

Table 4. Industrial Paint & Powder Magazine Survey Results: Types of Coatings Application Methods Currently Used at Companies Surveyed

Type of Coatings Application	%
Air spraying	66
HVLP spraying	29
Powder spraying	28
Air spraying, electrostatic	26
Airless spraying	20
Powder, fluidized bed	10
Rotary disks or bells	9
Electrocoating	9
Airless spraying, electrostatic	5
Other	7

Table 5. Types of Substrates Surveyed Companies are Coating and Expect to be Coating in 2 Years

Substrate	Now Use (%)	Average % of Use Now	Plan to Use (%)	Average % Plan to Use
Metal ferrous	78	57	78	57
Metal non-ferrous	53	25	55	25
Plastic	24	9	25	10
Wood	9	7	9	4
Glass	3	0.7	3	0.7
Other	6	4	7	4

Table 6. Types of Coatings Currently Used and Expect to be Using in 2 Years According to Surveyed Companies

Type of Coating	Now Use (%)	Average % of Use Now	Plan to Use in 2Years (%)	Average % Plan to Use in 2 Years
Powder	39	25	45	30
Conventional	41	22	37	17
Water-borne	35	15	41	19
Two-component	33	15	32	14
High-solids	30	14	27	12
E-coat	10	4	10	4
Radiation cure	4	1	5	2

Table 7. Primary Obstacles Holding Back Further Use of Each Coating Technology According to Surveyed Companies

	Type of Coating					
Primary Obstacle	**E-Coat**	**Powder Coating**	**Radiation Cure**	**High-Solids**	**Two-Component**	**Water-borne**
Cost of conversion	58.7%	59.8%	54.9%	10.7%	21.2%	19.8%
Cost of application	19.6%	22.7%	22.7%	6.9%	31.8%	8.5%
Poor application	13.6%	14.1%	12.5%	15.4%	14.4%	22.3%
EPA/VOC emission/ pollution	8.1%	2.5%	6.5%	64.1%	30.2%	6.2%
Poor performance	6.2%	6.9%	7.8%	5.9%	4.3%	51.2%

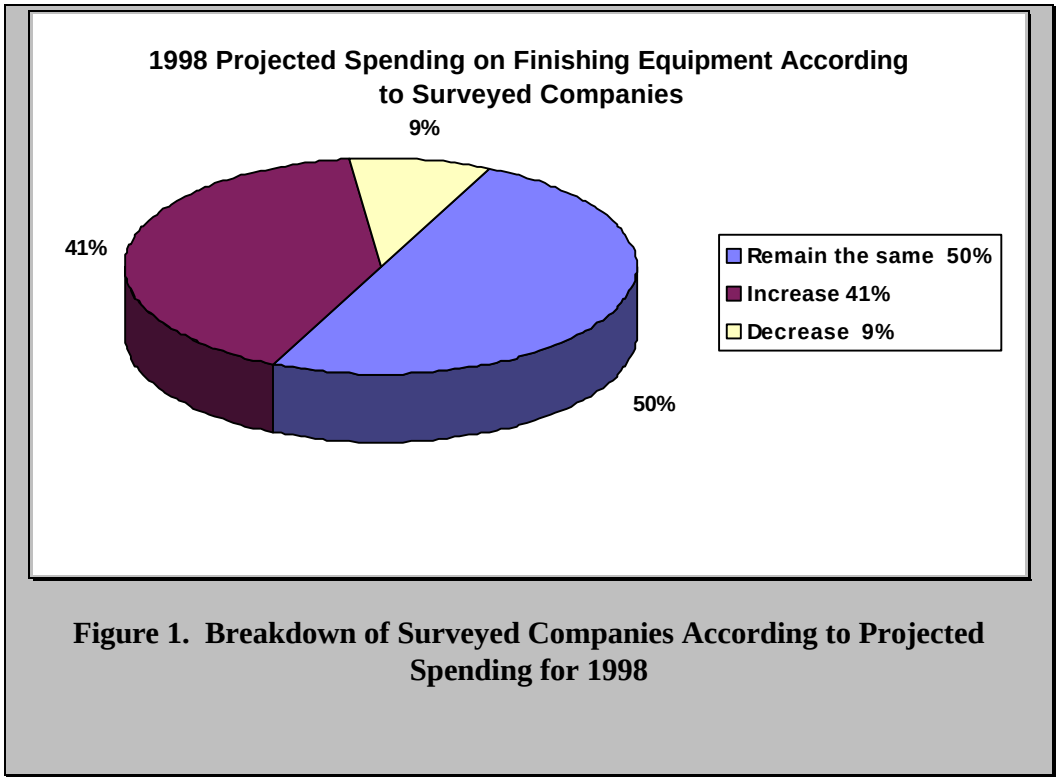

Figure 1. Breakdown of Surveyed Companies According to Projected Spending for 1998

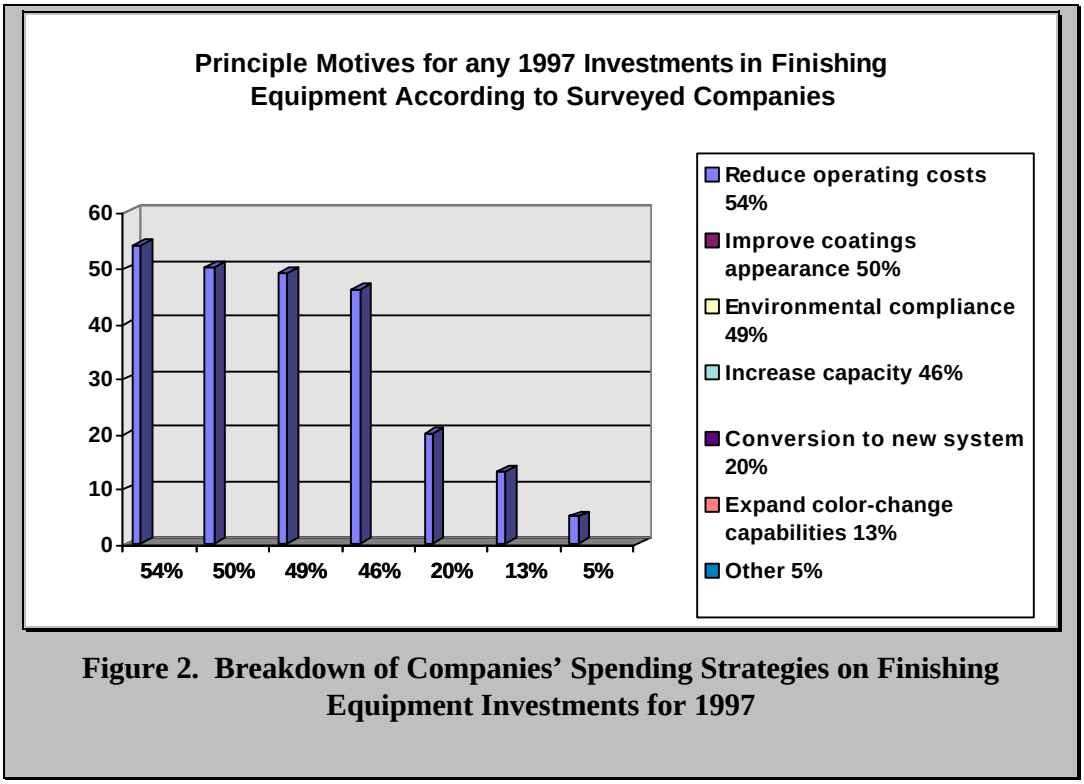

Figure 2. Breakdown of Companies' Spending Strategies on Finishing Equipment Investments for 1997

Table 8. Estimated Amount Surveyed Companies Will Spend on Finishing Equipment in 1997

Amount	%
Less than $10,000	33%
$10,000–24,999	17%
* $25,000–49,999	13%
$50,000–99,999	12%
$100,000–249,999	11%
$250,000–499,999	5%
$500,000–999,999	3%
$1,000,000–2,499,999	4%
$2,500,000+	2%

* indicates median

Table 9. Types of Equipment Surveyed Companies are Planning for Purchase in 1997

Type of Equipment	%
Spray booths	24%
Baking and curing	15%
Powder (spray)	12%
HVLP	10%
Coatings removal (blasting, stripping)	10%
Pollution control	9%
Air-atomized	8%
Air-atomized (ES)	7%
Turnkey system	6%
Airless/air-assisted airless	5%
Powder (fluidized bed)	4%
Radiation-cure (UV/EB)	4%
Disk/bell	3%
Airless/air-assisted (ES)	3%
E-coat	3%
One or more of above	49%

Table 10. Most Important Considerations When Purchasing <u>Coatings</u> According to Surveyed Companies

Considerations	% Companies
Coatings toughness/durability	58%
Color/appearance	35%
Ease of application/use	27%
Environmental benefits: VOC reduction	26%
Service/support	25%
Price	21%
Delivery	16%
Other	3%

Table 11. Most Important Considerations When Purchasing New <u>Application</u> <u>Equipment</u> According to Surveyed Companies

Considerations	% Companies
Equipment quality	67%
Price/value	22%
Service/support capabilities	18%
Environmental systems design	17%
Technical leadership	10%
Supplier reputation	10%
Delivery time	7%
Other	2%

SIC Codes

The SIC Codes pertinent to the miscellaneous metal parts and metal furniture coating industries are given below.

Industry Description	SIC Code
Metal household furniture	2514
Office furniture (except wood)	2522
Office and store fixtures	2542
Misc. primary metal parts	339
Misc. primary parts (not elsewhere classified)	3399
Misc. secondary non-ferrous metal parts	334
Misc. fabricated metal parts	349
Misc. fabricated metal parts (not elsewhere classified)	3499

Table 12. Coatings Usage as a Percentage of Total Market

	Powder Coatings Institute[1]			Industrial Paint and Powder Magazine				NPCA[2]
Coating Technology	1990	1995	(2000)[3]	1996 Consumption	1996 Usage[4]	1997 Usage[4]	1998[3,4]	1994
Solvent-based	71	63	53					
- High solids				16	32	30	31	32
- Low solids				26	45	41	36	22
- 2 comp.				15	35	33		
Waterborne	12	13	14	17	37	35	40	
Powder	11	15	22	23	26	39	45	25
E coat	5	7	8			10		
Radiation	1	2	3		5	4	6	
Other[5]								21

1 for all metal parts industries
2 for metal furniture industry
3 projected
4 percentage of sites using the technology (a total greater that 100% is possible due to using more than one technology)
5 not defined

Table 12 illustrates a definite reduction in low-solids, solvent- based coatings and in solvent-based coatings in general. High-solids coatings, however, are a significant part of the industry and are expected to remain a strong technology at least in the short term.

4.0 SUMMARY OF RESULTS

The following table summarizes and prioritizes the results of the focus area investigation for coatings and coating equipment. The table uses the top three technologies for coatings or equipment from all sources identified in this report.

Table 13. Summary of Focus Area Investigation Findings

	Source (Summary of Top 3 Priorities/Usage/Projections)							
	1 *	2	3	4	5	6	7	**Summary**
Application Technology								
Conventional air								**0**
HVLP	X				X			**2.5**
Electrostatic	X				X			**2.5**
Rotary	X							**1.5**
Air-assisted airless					X			**1**
Electrocoat						X		**1**
Autodeposition						X		**1**
Airless						X		**1**
Coating								
High solids (including 100%)				X	X	X		**3.6**
Solvent-based (HS, LS, PC)*			X		X			
Water-borne	X	X	X					**3.5**
Powder	X	X	X	X		X		**5.5**
UV	X					X		**2.5**
Low solids		X		X				**2.6**
Plural component					X			**1.6**

Key
1 - 1st stakeholder meeting (priorities counted 1.5 points each, all others counted 1 point)
2 - Industrial Paint & Powder magazine figures (coatings only)
3 - Powder Coating Institute survey (coatings only)
4 - National Paint & Coatings Association survey (coatings only)
5 - DOD Industrial Site survey
6 - ICEL matrix
7 - Industry consulting and information resource group (not yet available)

* Each X counted as 1/3 point each for HS, LS, and PC.

5.0 RECOMMENDATIONS

Based on the findings of *CTC*'s investigation, the recommended focus areas for verification testing of coating application equipment or processes are HVLP equipment, and electrostatic equipment. The recommended focus areas for coatings are powder, high solids, and water-borne.

These recommendations are based on the information documented herein, including:

- Discussions at the first stakeholder meeting (refer to minutes distributed in April 1997)
- Usage figures and projection of industry associations, organizations, and publications
- Usage figures and projections for DOD industrial facilities
- Potential of verification to impact the largest cross-section of the user community in various industries.

Other, more general, considerations were presented and discussed at the first stakeholder meeting. These considerations include the following:

- Highest P2 (pollution prevention) potential
- Multimedia environmental impact
- Highest volume applications
- Great potential for completing verification testing successfully and quickly
- Is verification a true implementation obstacle? (in other words, are products viable alternatives?)
- Lowest economic risks for implementation (in other words, implement 'in place'?)
- Realistic potential to meet performance requirements
- Practicality of implementation
- ETV is unique (in other words, can overlap with other studies or programs not necessarily duplicative)
- Potential for program/project leveraging.

Appendix A

Matrices of Pollution Prevention Potential from ICEL

DRAFT

The attached draft matrices come from the ICEL and were supplied by Vic Young, who as a member of the ICEL was instrumental in developing them.

Description of Matrices

Each matrix (one matrix per sheet written in Excel) pertains to a general area of interest within the coatings industry, such as pollution prevention and quality. Listed at the beginning of each row is a particular technology (for example, UV Coating and Electrodeposition) and at the top of each column is listed a particular area of interest (for example, VOCs and HAPs for the Pollution Prevention Potential matrix), which affects the general area of interest for the whole matrix. For each particular area of interest (column), there is room for placing a weight factor (defaults have already been placed in the attached matrices). For each technology (row), under each particular area of interest, there is given a rank and a place for a score to be calculated (already calculated on the attached matrices). Also, in the very last column, a total score can be tabulated (already calculated on the attached matrices).

Explanation of Matrices

Over a nine-month period, ICEL held meetings with many hands-on industry experts on coatings technology. These experts were from a diverse cross-section of the coatings industry, from automobile manufacturing to wooden office furniture to miscellaneous plastic parts. From the discussions at these meetings, a relative rank for how each technology affects each particular area of interest was determined and placed in the matrices (10 = strong positive impact, 1 = strong negative impact or no impact depending on the particular area of interest).

Each matrix is set up so that the user can write in a relative weight for each particular area of interest under the general area of interest's matrix (10 = most important , 1 = least important). The matrix will then multiply the weight by the rank to determine the score. It will also take the average for all the scores for a technology (along a row) and place the result in the total score column. The total score column is copied to the paints project master matrix. Higher scores indicate a more positive impact of using that technology on the general area of interest.

How to Use the Matrices

To use the matrices to give pertinent information about what technology would be able to improve a general or particular area of interest, first find the matrix in the Excel program that corresponds to the general area of interest or contains the particular area of interest. Decide what weight factor is appropriate for each particular area of interest (10 = most important, 1 = least important) and input the weights in the appropriate cells under the column headings. (Note that default weights have been entered on the attached sheets.). Once the weights are entered, the program will calculate scores and tally the total scores automatically. When the relative scores of two or more technologies are compared, the higher the score the more positive impact that technology will have.

For example:

A company currently uses low solids/high VOC wet paint and would like to determine a better coating type to improve the company's pollution prevention potential. The company would access the Pollution Prevention (P2) Potential - A matrix. Reviewing the particular areas of interest headings, the company experts have determined that the weighting of these areas are (see attached):

VOCs	8
HAPs	10
Effluent	9
Energy	3
Solid waste	7
Transfers	7

The program then calculates the scores and determines the total scores. From this analysis, the two technologies with the best P2 potential are 100% solids (liquid) and powder coatings.

If the case was that only HAP reduction was important, then the wet paint (acetone) would be considered as good an option as the 100% solids (liquid).

Now that a few top technologies have been found, an analysis could also be done to determine the relative impact each would have on quality or operating cost using the Quality and Operating Cost matrices to refine the task of deciding which technology to change to.

Appendix B

Summary of Stakeholders' Responses to the Initial Focus Area Report

Rad Tech International

Comments and suggestions from Alexander Ross, Ph.D., government affairs director:

- Expressed extreme satisfaction with *CTC*'s progress on the ETV-CCEP
- Suggested seeking out more end users of coatings rather than the trade associations for unbiased recommendations on which focus areas to include
- Encouraged focusing on water-borne coatings rather than high-solids coatings
- Urged including UV/EB curing coatings and specific types as focus areas
- Suggested including flat-line applications and 3D spray lines as specific radiation curing techniques
- Offered the addition of other substrates to focus area list that was created at the first stakeholders meeting; suggestion noted, but unable to add at specific location in document.

Chemical Coaters Association, Inc.

Comments from Larry Melgary, president of CCAI and Northern Coatings:

- Conveyed satisfaction with HVLP focus area document
- Discussed his involvement in coating industry
- Familiar with coating medical equipment and motor vehicles, not with metal furniture industry
- Uses bells and disks to increase transfer efficiency and to maintain production rates
- Seldom uses HVLP because of the large time-consuming factor
- Uses HVLP as a back-up finishing tool.